Professional Certification and Future Information Technology Knowledge Requirements

Interview Summaries

January, 1989

Abstract

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- *examine the processes used to certify professionals in a variety of fields characterized by rapid evolution of the underlying knowledge base and a high degree of specialization.*
- *examine the processes used to develop and administer certification tests in these fields.*
- *identify future trends and directions of Information Technology (IT).*
- *determine the future knowledge requirements of both users and IT professionals, based on the identified future trends and directions of IT.*

In examining certification and test development processes, INPUT interviewed representatives from 16 organizations including schools, IT-related professional organizations, and organizations from other professional fields such as engineering, accounting/finance, medicine, etc. To identify future trends in IT and associated knowledge requirements, INPUT senior staff undertook both secondary research and "brainstorming" sessions to develop a consensus on these issues.

In the area of "IT Futures," INPUT has developed both a knowledge outline and a set of recommendations for core and specialized certificates which JITEC might offer. INPUT's recommendations also included various ways in which JITEC could expand the scope of its activities to provide more of the continuing education and support services normally associated with profesional organizations.

The certification-related interviews provided examples of various ways in which JITEC could improve its testing program. INPUT recommended that JITEC staff meet with representatives of several of these organizations to exchange views and learn first hand about specialized techniques which have been developed to improve the testing process.

This document includes an introduction to the overall study, and summarizes the results of the 16 organizational interviews. It is provided as a courtesy to those ogranizations which generously agreed to meet with JITEC representatives.

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JITEC CERTIFICATION STUDY

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Introduction

I Introduction

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Background

Japan Information-Technology Engineers Examination Center (JITEC) has the responsibility for administration of the government-sponsored Information-Technology Engineers Examination (ITEE). In the 20 years since it was first implemented, the ITEE has grown from 2 categories of certification to 5. It has also achieved a very high reputation as an objective measure of the technological skill and knowledge which an individual has acquired in the field of information techology (IT).

The traditional procedure for developing examination questions has been a major factor in the past success of the ITEE. By using a team of active specialists in each field to develop the examination questions, JITEC has ensured that the test was always up-to-date and relevant.

However, as the examination categories have grown with the evolution of IT, the current procedure has become more complicated, difficult and expensive to administer. As the field of IT continues to evolve at an increasingly rapid pace, this situation will only get worse. JITEC is therefore reviewing the present system for areas of possible improvement.

As part of this effort, JITEC contracted with INPUT to perform a two part study. The first part involved interviewing a number of organizations which were involved in licensing or certifying professionals in a variety of fields characterized by rapid evolution of the underlying knowledge base and a high degree of specialization. The purpose of these interviews was to see how these organizations establish policy and handle issues such as core vs. specialized knowledge, the continuing revision of tests to reflect changes in technology, and the need for continuing education or recertification of current certificate or license holders.

The second part of the study required INPUT to identify future trends and directions in the area of Information Technology (IT), and determine how these trends would affect the future knowledge requirements of both users and IT professionals.

B

Scope and Methodology

In examining certification and test development processes, INPUT interviewed representatives from 16 organizations including schools, IT-related professional organizations, and organizations from other professional fields such as engineering, accounting/finance, medicine, etc. The list of organizations contacted is shown in Exhibit I-1.

Exhibit I-1 **Organizations Interviewed**

EDUCATIONAL ORGANIZATIONS (INFO TECH DEPTS -- REGULAR and EXTENSION)				
	#	University of California (Extension and Univ pgms)	Berkeley	CA
	#	Golden Gate University	San Francisco	CA
INFORMATION TECHNOLOGY ORGANIZATIONS				
		Association for Computing Machinery	New York	NY
		Data Processing Management Assoc	Park Ridge	IL
	#	EDP Auditors Association	Carol Stream	IL
*	#	Institute for Certif of Computer Professionals	Chicago	IL
	#	Office Automation Society International	Kensington	MD
OTHER PROFESSIONAL ORGANIZATIONS				
*	#	Amer Institute of Certified Public Accountants	New York	NY
*		Educational Testing Service	Princeton	NJ
*	#	Institute for Certification of Tax Professionals	Pasadena	CA
*	#	Institute of Chartered Financial Analysts	West Palm Beach	FL
	#	Institute of Management Consultants	New York	NY
*	#	Natl Assn of Securities Dealers	Washington	DC
*		Natl Board of Examiners in Optometry	New York	NY
*	#	Natl Institute for Certif in Engineering Technol	Alexandria	VA
*	#	Professional Examination Service	New York	NY

*NOTE: * indicates organization which prepares tests/administers testing program*
 # indicates organization which grants certificates/licenses

To identify future trends in IT and associated knowledge requirements, INPUT senior staff undertook both secondary research and "brainstorming" sessions to develop a consensus on these issues.

The certification-related interviews provided examples of various ways in which JITEC could improve its testing program. INPUT has recommended that JITEC staff meet with representatives of several of these organizations to exchange views and learn first hand about specialized techniques which have been developed to improve the testing process.

In the area of "IT Futures," INPUT has developed both a knowledge outline and a set of recommendations for core and specialized certificates which JITEC might offer.

INPUT's recommendations also include various ways in which JITEC could expand the scope of its activities to provide more of the continuing education and support services normally associated with profesional organizations.

It is important to note that this is a "zero-based analysis." The intent of this study was to assess the state of professional certification in the U.S. and recommend the best way to develop a certification program in the IT field. This was to be done without any prior consideration of JITEC's current plans, or its relationships with other professional organizations in the IT field. The only information provided to INPUT regarding JITEC's activities was a paper entitled *On the Information-Technology Engineers Examination System in Japan*. To the extent that INPUT's recommendations cover plans or activities already underway at JITEC, they serve to validate the importance of those efforts.

C

Organization of the Report

Chapter II, *Executive Summary*, provides an overview of the study, including the results of interviews and analysis of the future of IT, and outlines recommendations for changes in the structure of the ITEE.

Chapter III, *Interview Results*, summarizes the results of the interviews, including an overview of each organization surveyed, and the conclusions reached regarding issues of certification and licensing professionals in rapidly evolving fields.

Chapter IV, *Future Trends in IT*, presents the results of INPUT's analysis of the directions in which Information Technology will evolve over the next 5-10 years.

Chapter V, *Future IT Knowledge Requirements*, identifies the type of knowledge which will be required in the future of end users, applications developers, and system and hardware designers.

Chapter VI, *Conclusions and Recommendations*, provides INPUT's recommendations for changes in JITEC's approach to certification and the ITEE testing process.

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II Executive Summary

A

Background

As part of its effort to review the status of the Information Techology Engineers Examination (ITEE) and respond to the challenges of certifying professionals in a rapidly evolving technology area, JITEC contracted with INPUT to perform a study with the following objectives:

- *examine the processes used to certify professionals in a variety of fields characterized by rapid evolution of the underlying knowledge base and a high degree of specialization.*
- *examine the processes used to develop and administer certification tests in these fields.*
- *identify future trends and directions of Information Technology (IT).*
- *determine the future knowledge requirements of both users and IT professionals, based on the identified future trends and directions of IT.*

In examining certification and test development processes, INPUT interviewed representatives from 16 organizations including schools, IT-related professional organizations, and organizations from other professional fields such as engineering, accounting/finance, medicine, etc. To identify future trends in IT and associated knowledge requirements, INPUT senior staff undertook both secondary research and "brainstorming" sessions to develop a consensus on these issues.

B

Professional Certification and Licensing Processes

INPUT surveyed 3 kinds of organizations involved in professional certification or licensing:

- professional organizations involved in licensing
- schools which offer certificates for specific educational achievement
- professional organizations involved in certification

Several professions uniformly require state licensing before individuals are allowed to practice as professionals dealing with the public. Among these are law, medicine, engineering, accounting, etc. In these cases, the legal requirement for a license is intended to guarantee that all professionals meet a minimal standard of competence and adhere to ethical practices. Although it is always possible to find a job in these fields without being licensed (e.g., a person with a law degree who has not passed a bar exam can do legal research and teach law), the general tendency is that anyone who can be licensed is licensed. In many cases, states grant a national professional group the responsibility of developing and monitoring tests and test procedures that are used by state licensing groups.

Schools generally offer certificates in applied or specialized fields of knowledge, such as data processing, accounting, marketing, landscape architectue, etc. These certificates are career-oriented, in that the recipients have received an in-depth background in a specific area, and the certificate attests to their ability to function as effective practitioners in that area. Many of the courses offered by schools which provide such certificates are taught by part-time instructors who are currently employed as technicians or managers in the field. This ensures that the knowledge gained is both current and related to practical problems.

In fields which do not require licensing, national professional organizations offer certificates which serve to establish a person's mastery of the field. However, since certification is a voluntary process, the majority of professionals in any such field are generally not certified. Those who are certified tend to become the leaders in their field, being active in professional organizations and attempting to advance the state of their profession. Many firms look with favor on their employees' efforts to become certified and pay the costs of associated education and training. In addition, while certification is generally not an *a priori* job requirement, most firms look with favor on a job candidate who has made the effort to demonstrate his competence and become certified in his field.

In almost all cases, certification or licensing involves passing an examination on the defined core skills. Only a few professional organizations base certification on a person's background (education, work experience, references), without requiring a separate, additional examination. And all of these are planning to institute some form of examination in the future.

While licenses are required for some jobs, and certificates are not, the approach to defining a knowledge base is the same in both cases. Both licenses and certificates generally focus on a core set of skills which are required for effective practice in the field. At the present time, there is little specialization in either license or ceritificate oriented fields, although many organizations are considering developing them in the future. Where there is specialized certification (e.g., in medicine), it is often based solely on satisfactorily completing a specific course of study and/or work, after which the specialized certificate is automatically granted.

In addition to little specialization, there is little focus on multiple, hierarchical levels of certification or licensing. In general, with licensing there is a single core license, and possibly several associated subspecialties. But since the license only attests to a defined minimum level of core skills, there is a need for only one core license. Additional levels of skill and experience are then attested to by certification or membership in specialty boards or subcommittees of a professional society.

The small emphasis on multiple levels of certification does not mean, however, that the certification process itself is not multi-level. Several organizations have a series of examinations which must be taken in sequence, with significant time gaps (e.g., one year or more) between exams. In addition, some organizations require that the candidate pass a hierarchicaly structured set of courses as part of the certification process.

One of the most important aspects of both licensing and certification programs is the agreement to adhere to a code of professional ethics. Normally a person who is certified belongs to an association of those certified in that field. Violations of the code of ethics will result in the person's expulsion from the professional association, and revocation of the person's certification. Similarly, violations of professional ethics can result in revocation of a license, although this is usually done by the state agency granting the license rather than be a professional organization.

C

Development and Administration of Examinations

Professional organizations normally develop and operate their programs through a set of voluntary committees of industry experts. These experts work to define the appropriate knowledge base to be evaluated, and the types of questions to be asked. In the case of professional organization certification, test administration is usually managed by the paid staff of the organization. In the case of licensing, the pattern varies; in some cases (e.g., with the National Association of Securities Dealers), the association gives the exam; in other cases, the state gives the exam.

All large-scale testing is done on an objective basis (i.e., multiple choice or true/false) due to the difficulty of grading essay tests. However, some smaller programs use at least partial essay exams and find them valuable for determining how well an individual understands and can apply the knowledge being tested.

Most testing programs maintain a wide variety of statistics on their tests and test questions. In addition, individual test items are carefully analyzed to ensure that they are meaningful and effective; misleading or "trick" questions are discouraged by all organizations.

There are a variety of approaches to test development and question reuse. In some cases, a "question bank" is maintained, and individual questions are pulled from the bank to make up a test. In other cases, similar but new questions are developed for each examination. However, all organizations provide candidates with a curriculum outline defining the areas of knowledge the examination will cover, as well as a sample set of questions for the exam. In at least one case where there is a new exam every year, the candidates are provided with copies of the last 3 years' exams.

The curriculum outline for the examination is perhaps the most important aspect of the entire process, as it serves to authoritatively define the field. It is in this area that most of the important work of professional societies is done.

D

Future Trends and Directions of Information Technology

The future components of information technology may be organized into five categories, as follows:

- Independent Processors
- Embedded Processors and Other Associated Hardware
- Networks and Communications Systems
- Software
- Public-Interface Systems

Chapter IV discusses likely trends in each of these areas. As part of the continuing process of developing the ITEE, JITEC should monitor these trends and update this outline at least every 2 years. The outline can then be used to guide development of specific examination questions covering each of the evolving areas.

In the area of independent processors, INPUT sees a gradual erosion of the current distinctions between minicomputers and microcomputers/workstations. Meanwhile, two new classes of specialized machines will become important:

- fault-tolerant transaction processing machines
- database machines

More devices of all types will be controlled by embedded processors, including such things as consumer electronics and hardware, vehicles, gasoline pumps, etc. This local intelligence will also allow significant improvement in user interfaces, with personalization/customization of devices becoming possible. The quality and cost performance of graphics systems will also increase dramatically as a result of increased application of specialized embedded processors.

Networks and communications capabilities will become much more important over the near term. As user applications shift towards a more real-time basis, they will come to be increasingly dependent on communications. In addition, the shift toward work group or departmental computing will depend on the availability of effective communications. One of the most serious challenges facing the field of telecommunications will be the integration and management of a wide variety of both old and new systems.

The major trends in software will be increasing user friendliness and a shift to open systems. Software will become much more important than hardware as the cost of hardware continues to decline while the cost of software continues to climb, and as open systems reduce the importance of specific hardware platforms. More applications will be developed under highly structured methodologies, and with the use of sophisticated data modelling and system development (CASE) tools. Specialized tools for analyzing and restructuring existing applications and databases will become increasingly important as old applications have to be replaced and/or integrated into a modern systems environment.

Finally, there will be a significant growth in the extent and quality of public interface systems. This trend will be driven by many of the other trends listed above, including improved communications, the trend to real-time processing, and the availability of higher quality interfaces (e.g., better graphics, voice response, etc.).

E

Future Information Technology Knowledge Requirements

With the increasing domination of modern life by Information Technology, it is not only the IT professional that must know how to apply these tools; end users also have specific knowledge requirements which must be met if they are to make effective use of the applications developed by IT professionals. Also, increasing numbers of end users are applying utility applications software (e.g., word processing, graphics, spreadsheets, etc.) to their daily tasks.

In addition to end users, there are two separate categories of IT professionals:

- Application developers/maintainers
- Developers/maintainers of hardware and software systems

Applications development professionals are primarily focussed on implementation of specific user-oriented applications. Their knowledge requirements are heavily oriented towards *using* tools -- hardware, software, utilities, etc. -- to solve the user's problem. In addition, they must know how to analyze the user's requirements and design a system which is implemented through these tools. By contrast, developers and maintainers of hardware and software systems are primarily tool *builders*, supporting the requirements of the applications developers.

End users may be divided into three categories, based on the nature of their work and the amount of IT knowledge they require to perform their jobs. At the lowest level, there is little knowledge required beyond the mechanics of the application. At the second level are people who independently use utility applications software. They work with the tools, but do not develop applications as such. At the third level, the most sophisticated user creates personal applications using system utilities, programming languages and/or macro capabilities found in utility applications (e.g., spreadsheets, DBMS, etc.), and other similar tools. This person must understand programming concepts as well as the specifics of system utilities and application building tools.

Specific knowledge requirements for each of these categories have been spelled out in Chapter V. In general, the highest level user has many of the same knowledge requirements as the applications development IT professional, although at a somewhat lower level of detail and sophistication. In addition, the developers/maintainers of hardware and software systems share the same core knowledge base with the applications development professionals. The primary difference between applications and systems professionals is the increased level of mathematics and physical science/mechanical engineering required by the systems professionals, which has little or no applicability to the development of end-user applications.

F

Conclusions and Recommendations

The survey of professional licensing and certification organizations provided a good overview of the current practices in this area, as well as a number of specific issues which JITEC should consider. The review of technology futures and associated knowledge requirements provided the basis for an outline of future examinations which JITEC might consider offering. Based on these two efforts, INPUT has produced a set of general observations and conclusions regarding the JITEC programs, and a specific set of recommendations for a proposed revised certificate structure.

1. General Observations and Conclusions

In general, both licensing and certification involve most or all of the following:

- an educational requirement to acquire and maintain a body of knowledge
- some level of work experience
- an examination to test whether the candidate has an acceptable understanding of the subject matter
- some sense of responsibility to society with regard to the use of this knowledge
- a code of ethics
- association with a professional society

These factors should all be worked into JITEC's examination program in some manner or another.

JITEC should also consider the following types of changes to its current examination program:

- the use of essay-type questions
- the use of real-time, computer-based examinations
- establishing a process for recertification or renewal of a certificates

During its surveys, INPUT identified a number of organizations that are currently on the leading edge of test development and professional certification. Those which INPUT recommends be visited by JITEC are:

- Institute for Certification of Computer Professionals (ICCP)
- Educational Testing Service (ETC)
- National Board of Examiners in Optometry (NBEO)
- National Association of Securities Dealers (NASD)
- National Institute for Certification in Engineering Technology (NICET)

In addition to a simple visit, INPUT strongly recommends that JITEC attempt to forge a continuing relationship with these organizations.

One of the leading forces in the development of Information Technology in the United States is the Association for Computing Machinery (ACM). As one of the major associations sponsoring the ICCP, ACM is strongly involved with definitions of curricula, school accreditation, etc. Over the years, ACM has had an ongoing series of projects aimed at defining the knowledge base of IT. It is therefore strongly recommended that JITEC forge a permanent working relationship with ACM as well.

2. Specific Revisions to the ITEE

INPUT recommends that JITEC consider revising ITEE along the following lines:

2.a. General Certificate Requirements

Each certificate should be subject to 7 general categories of requirements:

- basic education level
- relevant work experience
- completion of lower level certificates, where relevant
- reference checks/professional recommendations
- passing of the examination
- periodic recertification or renewal of certificates
- membership in a professional association, with an associated ethics pledge

2.b. Categories of Certificates

There should be 3 categories of certificates:

- IT Core (ITC) certificates
- Applications Development Specialist (ADS) certificates
- Industry Specialist (IndS) certificates

2.c. Levels/Types of Certificates

Within the above categories, there should be multiple levels of certification, as well as some degree of specialization. The complete list of proposed certificates is as follows:

Level I

- ITC: Information Technologist
- ADS: Systems Auditor
  Database Specialist
  Telecommunications Specialist
- IndS: (as many as appropriate, including such areas as banking/finance, manufacturing, etc.)

Level II

- ITC: Hardware Engineer
  Software Engineer
  Telecommunications Engineer
  Applications Development Engineer
- ADS: Senior Systems Auditor
  Senior Database Specialist

Level III

- ITC Information Scientist

III Interview Results

A

Background and Interview Process

At the start of this study, INPUT developed a questionnaire/interview guide to direct the interview process. Since the interview targets were so diverse, not all items on the interview guide were applicable to all interviews. However, in many cases the interviewees provided valuable insights into areas which had only indirect bearing on the activities of their organization.

After review and approval of the interview guide by JITEC, INPUT conducted a preliminary set of interviews to collect information about the nature of certificates and the certification process, and set the background for the subsequent interviews. Three kinds of organizations were selected:

- organizations which sponsor the Certificate in Data Processing
- the leading local school in career-oriented IS education
- a non-IS professional certification organization

The focus of these initial interviews was on policy-oriented issues, and they served to set the stage for the remaining interviews. These remaining interviews placed more emphasis on the details of the testing process, and specific approaches to licensing and certification.

The complete set of organizations interviewed is listed in Exhibit I-1. The interviewees included schools, IT-related professional organizations, and organizations from other professional fields such as engineering, accounting/ finance, medicine, etc.

It should be noted that this report reflects INPUT's synthesis of the various comments of the persons who were interviewed. Many of these opinions are very candid and may be controversial. It should also be noted that these comments reflect the personal opinions of the persons interviewed and do not represent official statements or positions of the organizations involved.

The remainder of this chapter is organized into three parts:

- Section B discusses several important issues involved in certification
- Section C summarizes the results of interviews with various categories of organizations
- Section D summarizes each of the interviews

B

Licensing and Certification Related Issues

1. Certificates vs. Licensing

A certificate provides evidence that its holder has satisfied some authoritative body that he/she has a specified level of knowledge or competence in a specified field. Although some certificates give their holder the legal right to use initials after his/her name (e.g., CDP, CLU), they confer no other formal right or privilege.

By contrast, while a license provides the same kind of evidence that its holder has a specified level of competence, it also grants a legal right to the holder to engage in some professional activity that cannot be practiced without it. In general, these activities involve the provision of "expert" services to the general public -- services which are valuable, but risky if performed incorrectly, and the public has no way of assessing the qualifications of the expert other than through the license.

Since they confer a legal right, licenses are normally granted by a governmental authority. By contrast, certificates are normally granted either by professional organizations or schools. The key point about certificates and licenses is that they are both career-oriented credentials; their basic purpose is to further specific career goals of their holder, not to demonstrate a level of general knowledge. This is the function of an academic degree.

2. Continuing Education Units (CEUs)

Closely related to licensing is the concept of a Continuing Education Unit (CEU). CEUs are a measure of additional knowledge which a person has gained related to a specific field. A CEU is defined as 10 hours of participation in an organized continuing education activity. CEUs may be granted for attending courses or seminars, workshops, internships, or other forms of practical experience which are not associated with an academic credit program. The CEU offers a person a documented record of noncredit educational achievement, as well as providing a standard basis for measuring diverse types of learning experience.

CEUs may be granted by a wide variety of educational and training organizations, including colleges and universities; by professional societies, associations, and corporate training groups; hospitals; and by individuals. CEUs can be earned in a wide variety of relevant subjects. A nurse, for example, could study psychology, organizational behavior, computer science, or anything else that had a demonstrable relationship to the practice of nursing.

In order to maintain a current license in several professional fields (e.g., nursing), a person must *either:*

- earn a specified number of CEUs over a 2 year period; or
- retake the current licensing exams to demonstrate current proficiency.

In general, most professional licenses either do not require periodic renewal or, if they do, use the CEU mechanism to establish that the person has current knowledge of the field.

There is no central or governmental control over the quality of CEU offerings. However, the Council on the Continuing Education Unit (CCEU), which was formed in 1977, establishes guidelines for conduct of educational programs or activities which are eligible to grant CEUs. State government agencies which issue professional licenses recognize the organizations certified by CCEU and allow CEU credit towards license renewals based on that CCEU certification.

3. Source, Authority and Credibility of Certificates

In the U.S., anyone can establish a process to grant a certificate. They are not regulated or standardized by any governmental authority. In general, there are two categories of certificate grantors: professional organizations and schools.

Professional Organizations

Because of their tax exempt status, professional organizations must register a statement of their purpose and activities with the U.S. government. Also, their names, initials, etc. are generally registered and protected by Copyright law. Also protected is the use of a registered designation granted by a professional organization (e.g., Certified Public Accountant (CPA), Chartered Financial Analyst (CFA), Certified Data Processor (CDP), etc.).

Because professional societies generally have a specific industry orientation and serve as the focal point for industry developments, their education, testing and certification programs are restricted to their industry. Their authoritative role in the industry and their ability to control qualifications, rights and responsibilities of membership gives a strong sense of credibility and value to any credentials they develop and issue. In addition, most people are aware of the various professional credentials and certifications which are relevant to their industry and the standards of knowledge and/or achievement which they represent.

Since there is little overlap in the focus of most professional societies, there is seldom a problem of multiple societies competing to issue credentials in the same field. When there is a serious overlap, or a common body of knowledge which is relevant to many specialized groups, these groups may work together to create an Institute or other separate organization which handles the certification for all its members. The ICCP is a good example of this situation.

Schools

By contrast, there are many schools which teach the same subject matter, and all award credentials (degrees and/or certificates) to their graduates. While schools are subject to accreditation reviews to ensure that their overall programs meet certain minimum standards, there is no central control over the knowledge represented by a specific degree or certificate. Each school, together with its graduates and their credentials, is evaluated in the market by people who purchase its output -- the graduates.

With degrees, there is some basic level of consistency in definitions: a bachelor's degree represents the same general level and breadth of knowledge in a specified field, no matter what school it is from. This is ensured by the accreditation process. What differs from school to school is the quality of the students and their knowledge: a Harvard degree is presumed to identify a higher quality graduate than would a degree from a small local college. The same situation prevails with certificates -- a certificate from a well-known school is more respected than a certificate from a lesser school. However, since there is no consistency in definitions of what school-issued certificates represent, each one must be evaluated individually, taking into account both the source of the credential and the specific requirements for the certificate.

In evaluating school-issued certificates, one of the key factors to examine is how the certificate was developed. The best approach is for a school to work with professional organizations to develop the certificate requirements. This ensures that the certificate is relevant to industry needs. In addition, it helps the school build its curriculum in the direction of students needs, thus enhancing the quality and reputation of the school.

A second major factor is how the type of instruction required for the certificate fits into the school's regular curriculum. In the best case, a certificate is based on the same courses required for a degree. In this situation, the only difference between the certificate and a degree is that a certificate represents mastery of a specific, narrow field, whereas a degree represents a significantly broader range of knowledge; both require the same level and quality of education. This is the situation at Golden Gate University.

Certificates issued by a separate "Extension" division of an academically-oriented school are generally of lower quality and less valuable. The University of California is a case in point. The Extension Division offers a wide range of courses and certificates, but these are not a part of the regular University programs, and the University will not allow academic credit for courses taken in its own Extension Division! UC does not characterize itself as a career-oriented school; GGU does. As a result, UC cannot leverage its academic programs in support of career-oriented certificates the way GGU can and does.

While both UC and GGU use industry professionals to teach courses on a parttime basis at night, at GGU these teachers and their courses are integrated into the regular curriculum and subject to the same quality control as regular full-time faculty. By contrast, the Extension instructors have no faculty status with the University, and while the basic curriculum plan for each certificate is reviewed and approved by the Academic Senate, the work of the Extension instructors is not subject to review by the Senate. The Academic Senate argues that certificates imply a narrow of focus and therefore have no place in a broad-guaged setting such as the regular University programs. While this may be logically correct, the result is an unfocussed, second-class program in an otherwise first-class institution.

By contrast with its Extension programs, however, UC has one of the finest formal (degree) programs in the nation in the areas of Business and Information Science. However, as with Stanford, these programs are inflexible, requiring full-time attendance and a breadth of requirements which are not necessarily of interest to the (generally older) career-oriented student who is seeking a credential to further a specific employment-related goal.

4. Value of Certificates

Since a certificate

> *provides evidence that its holder has satisfied some authoritative body that he/she has a specified level of knowledge or competence in a specified field,*

its value is derived from the "blessing" that the authority has given the individual. This value can be both psychological and real.

The U.S. is a "certificate-mad" society. To many people, a certificate saying "you took 5 classes in subject X" is more valuable than any knowledge gained from those classes. Students or professionals with feelings of inadequacy often try to collect as many certificates as they can, and display them as evidence that some authority has said they are competent. As "products of a credentialed society," such people pursue certificates to realize a sense of accomplishment -- the same way they pursued merit badges when they were children in the Boy Scouts.

Such people will also take classes at a place which offers certificates just to get the certificate, even though the same courses are available at much lower cost with equivalent quality at a school which does not issue certificates. For example, many people attend courses given by the American Management Association, which issues certificates, even though the same knowledge may be gained from courses at a local community college.

Because certificates are not regulated, they represent a free market for their offerors. Some organizations not only charge high prices for certificates, but also make their programs hard to get into or their credentials hard to obtain. As the price rises -- in terms of both money and time, the certificate becomes a scarce commodity and its perceived value rises.

Aside from these psychological values, there is also a real value placed by employers on the possession of a certificate. In general, certificates are most important in an area where new technology is emerging or laws and regulations are rapidly changing. Both of these situations involve a rapidly shifting knowledge base, and it is important to potential employers to know that a person has current skills and knowledge.

Since the knowledge base of a single area will change over time, so will the content of a certificate in that area. This means that the age of a certificate is important (as well as its source). At a managerial level, where current technical knowledge is not so important, an old certificate still has value -- a "halo effect" demonstrating that the person has at least met a challenge, at least started and completed a project. At a more junior level, in cases where a person has been "out of the market" for some time (e.g., a professional woman who quit work to raise a child), a new certificate will help that person market themselves as being current in their field despite the recent out-of-market situation.

For businesses, especially those which offer internal training programs or support their employees' external education, the age of certificates is not as important in the hiring process as the fact that a person has them. Such businesses feel they can train their employees in whatever technical skills they need, and a certificate -- even an old one -- provides evidence that the person is trainable.

By contrast, the U.S. government does not generally have good training programs for its employees. Also, government employment is often a lifelong commitment and it is very difficult to dismiss someone from the civil service. Since the government must also be careful to use objective, non-discriminatory hiring criteria, they are always looking for ways to ensure that they identify and hire people who are immediately qualified for their jobs. In technical areas such as IS, there is a strong trend towards hiring "certified" professionals who have well-defined skills and meet specific standards.

5. Equivalency (Experience) Evaluation

One of the most difficult tasks in developing a certification program is how to handle work experience. There are three components which may be evaluated in a certification process:

- education
- experience
- test results

Education and test results are easiest because they provide objective evidence of specific knowledge. Evaluating experience is much more difficult. It is common practice to trade off education and experience in specifying requirements for various credentials; for example:

> a bachelor's degree, or 4 years of experience

However, the problems of evaluating what the person has learned in the period of experience are complex and often not well handled.

There is controversy over whether or not experience should be a requirement for a certificate, but this controversy simply reflects the free market nature of certificates and the opinions of those who are involved; there is no right answer to the question. The important issue is to ensure that experience, if included, is properly analyzed. Unfortunately, this is a subjective process and cannot be handled effectively for large numbers of people. Thus, for mass certification programs such as the one run by ICCP, experience should probably not be evaluated as part of the certification process, although a requirement that a person have worked in a field for some minimum time period might be considered reasonable.

If experience is to be evaluated, two key points should be covered: reference checking, and an in-depth review of the experience by a person or committee of professionals who can interview the candidate and probe for accomplishments, knowledge gained, problems solved, etc. Unfortunately, since this is a subjective process, it is subject to criticism as discriminatory under U.S. Civil Rights law. This is one of the reasons why such a detailed evaluation is seldom undertaken.

6. Characteristics of Certificates

Because of the unregulated, free market nature of certificates, there is no explicit relationship between certificates and CEUs. Organizations may offer one or both, and may or may not link them. In general, an Extension-type program may issue both, but a program such as GGU where the certificates are based on standard academic coursework will not issue associated CEUs because the required work is not "Continuing Education." Schools such as GGU may, however, also have continuing education courses unrelated to the academically-based certificate programs and offer CEUs in conjunction with these.

In general, there is also little interrelationship between certificates. Although some schools and professional organizations have a core program with several levels of certificates, most certificates are evidence of specialized knowledge which is unrelated to other certificates. Except in the multi-level core knowledge situation, few certificates have any prerequisites.

Since certificates generally relate to specialized knowledge, they tend to focus on hands-on, technical subjects rather than more general or managerial skills. Most certificate grantors state that their purpose is to establish standards and ensure the quality of people who are practicing a specific function. This creates a problem in cases where members of a professional organization cannot agree on the definition of their required skill/knowledge base. Several organizations (such as the Association for Systems Management) have not been able to agree on these issues and therefore do not participate in any certification program.

In the IS area, as well as others, there are often two categories of certificates, based on the objectives of the person seeking them:

- those who are (or intend to be) professionals in their fields
- those who are users seeking either to expand their general background or to acquire specific additional skills

For those seeking professional credentials, there are two further categories:

- theoretically/technically-focussed (the tools necessary to do the job)
- analytically/managerially-focussed (how to apply the tools to real situations)

In general, the theoretical or tool-oriented focus parallels the focus of undergraduate IS programs in U.S. schools, while the managerially-focussed certificates parallel the graduate courses. User-oriented programs also tend to be tool-focussed, but they are more practically oriented than theoretical.

In the professional area, these distinctions tend to parallel the traditional career path in IS:

- programmer (technical/tool oriented skills)
- analyst (how to apply those skills to practical problems)
- team leader/project manager (how to make it all happen)

C

Observations from Categories of Interviewees

1. Certificate Programs Associated with Schools and Colleges

There are many organization in the U.S. that award certificates or otherwise denote successful completion of a course of study. Professional societies, correspondence schools, technical schools, colleges and universities are examples of such institutions. Golden Gate University (GGU) and the University of California Extension Program (UCEP) are two that INPUT contacted.

Both schools are nationally accredited universities. GGU is a graduate Business school that awards BA, MBA, MS, and DBA degrees. The UCEP is affiliated with the University of California at Berkeley, which offers a full range of degrees, including BA, BS, MBA, MS, MA, and the PhD. However, UCEP does not award any degrees. UCEP capitalizes on its affiliation with the distinguished University of California to attract students and enhance the value of participating in its programs. In fact, one of the stated benefits of receiving a UCEP Certificate, is that this Certificate carries with it an affiliation with the University of California. UCEP currently offers over 20 different Certificate programs in such diverse fields as accounting, marketing, landscape architecture, telecommunications engineering, business data processing and others.

Both schools develop new Certificate programs by performing a "needs assessment" in a particular field of study and by orienting the program around a body of knowledge significant to the field being examined. Advisory boards composed of industry specialists are convened for each program. Each Certificate program must meet very strict university curriculum standards and must go through an iterative development process with several review phases, before it becomes an accepted program. At UCE, each program is reexamined and reapproved or revised every 5 years. From time to time programs that are no longer effective or useful to students are dropped.

A Certificate program provides several major benefits. First, it prepares a candidate in depth within a subspecialty. Second, employers see a recipient as someone who is extremely committed to a certain concentration within a body of knowledge. Candidates feel that a Certificate is useful in job searching, and is valuable for career advancement and salary increases.

2. Licensing and Registration Programs

Several professions require state licensing before individuals are permitted to practice. While the licensing procedures vary widely depending on the disciplines involved, INPUT interviewed a number of organizations that are involved in state licensing projects. In these instances, most of the states grant a national professional group the responsibility of developing and monitoring test procedures that are used by the state licensing groups.

Groups that have been involved in such procedures for many years have both extensive experience with supervising such examination programs and a broad knowledge of evolutionary changes and improvements that have emerged through the years. For example many organizations provide candidates with extremely comprehensive manuals describing the procedures involved in the testing program, how examinations are developed, sample test questions, detailed discussion of the subject matter to be tested and other information that is useful to candidates.

Some of the groups have put together papers that are very useful to subject matter experts and question preparers. There is a broad range of papers covering the subject of statistics that have been acquired over time. Information on pass/fail rates, follow up on individual professional advancement, test and question bias, and many other important details have been generated over the years. Much information can be obtained from further contacts with the surveyed organizations.

Most of the organizations called have a very active and continuous review program. Such programs are vital to maintaining an examination policy that stays current with the field and is an effective vehicle for testing applicants. It would be constructive to view some of these committee reports and recommendations to determine whether there are any that may be relevant to JITEC interests.

One of the more interesting aspects of the testing procedures that the National Board of Examiners in Optometry has developed is a feedback mechanism available to each examinee. Candidates are permitted to address complaints, comments, or critique on an actual examination paper. These get immediate review and analysis by committees to determine the significance of the points questioned.

Other issues that were uncovered that warrant additional study include the use of workstations or terminals for taking examinations and the use of computers to prepare a randomly generated, and individually tailored exam to each candidate taking the exam. This could eliminate the need for setting up scheduled examination dates and places to accommodate large numbers of applicants.

3. Certification Programs

By far the largest group of organizations surveyed were involved in programs where candidates voluntarily participate to gain peer recognition, enhance employment opportunities, better pay or gain higher professional recognition in a field. While there are a wide divergence in the kinds of certification programs that exist in the various disciplines surveyed, there are some common components. In general, certification of professionals includes:

- an educational requirement to acquire and maintain a body of knowledge
- some level of work experience
- and examination to test whether the candidate has an acceptable understanding of the subject matter
- some sense of responsibility to society with regard to the use of this knowledge
- a code of ethics
- association with a professional society

Most organizations develop and monitor their programs through committees composed of highly qualified professionals. Currently, most groups provide a certification program that tests a broad general knowledge base. Examinations most frequently use multiple choice questions, although many certification programs also use essay-type questions as well as problem solving questions to measure skills.

As yet, the introduction of more specialized knowledge tests is small. However, many organizations have indicated that specialized test programs are being considered for some time in the future. Many organizations are concerned about a continuing education requirement, or a recertification process so that recipients must maintain their proficiency in some manner.

Statistical studies are produced by most organizations. These studies include test analysis, pass/fail information, career tracking and geographical studies.

Standards relative to certification programs are being strengthened in many organizations. This generally means that groups are looking toward expanding experience requirements, education requirements, and in some instances, offering several levels of certification ranging from an entry level certificate through a more advanced certificate and a senior level certificate for the most distinguished recipients.

In examining the current status and future direction of the JITEC program, it is important to understand that there is room for all kinds of certificates. Professionals look upon achieving such a level as a mark of competence and a recognition that the person is a dedicated and committed expert.

D

Summaries of Individual Interviews

The summaries in this section are grouped as follows:

Educational Organizations

1. University of California Extension Program (UCEP)
2. Golden Gate University (GGU)

Information Technology Organizations

3. Association for Computing Machinery (ACM)
4. Data Processing Management Association (DPMA)
5. (Links Between ACM/DPMA and Other Data Processing Associations)
6. EDP Auditors Association
7. Institute for Certification of Computer Professionals
8. Office Automation Society International

Other Professional Organizations

9. American Institute of Certified Public Accountants
10. Educational Testing Service
11. Institute for Certification of Tax Professionals
12. Institute of Chartered Financial Analysts
13. Institute of Management Consultants
14. National Association of Securities Dealers
15. National Board of Examiners in Optometry
16. National Institute for Certification in Engineering Technologies
17. Professional Examination Service

Educational Organizations

1. University of California Extension Program (UCEP)

The UCEP is an example of University sponsored programs where students can earn certificates for specialized and concentrated studies. Unlike many other universities in the U.S., the UCEP is set up as a separate and independent division of the University of California. Students who study in UCEP do not work for or receive degrees from the University. UCEP expects that the prestige of receiving a certificate that carries the banner of the University of California is enough of an incentive to warrant candidates pursuing their programs.

The UCEP currently offers over 20 certificate programs in a wide variety of disciplines. Certificates are offered in purchasing management, accounting, publishing, business and management, business data processing, and others. The certificate program is quite similar to those offered at other institutions. Essentially, a candidate takes a prescribed number of courses, with most of the courses specifically identified. Upon completion of all of the courses the individual then receives the certificate.

All of the UCEP certificate programs are focused to meet a very specific need in a discipline or subject. If a program no longer is considered effective, it is terminated or revised. All certificate programs are developed by advisors composed of people from industry and education who are familiar with the specific needs or interests of that industry. The programs have to be approved by an academic policy committee. There is a review of each program by the University of California academic policy committee and the academic department most concerned with each program. Final approval for a new program however, rests with UCEP. There is a 5 year review policy for all certification programs. In this manner ineffective or outmoded programs can be weeded out.

The UCEP certificate programs are considered very practical for two major reasons:

- each certificate program prepares the candidate on an in depth viewpoint in a particular field.
- studies indicate that employers are more supportive of employees who commit themselves to improve their knowledge that are job related.

2. Golden Gate University (GGU)

Golden Gate University is a private, non-profit university accredited by the Western Association of Schools and Colleges. With a combined enrollment of over 10,000 day/evening students, it is the third largest independent university in California. GGU offers degrees at all levels (Associate, Bachelor, Master, and Doctorate), as well as a variety of Certificates in specific fields.

The mission of GGU is to provide high-quality, professionally-oriented education programs for persons preparing for, or already engaged in, careers in business, public service and law. Within the College of Business Administration, Schools of Management and Telecommunications Management offer the broadest range of IS-related courses, degrees and certificates of any institution in the San Francisco Bay Area. There are also a wide variety of offerings in related fields such as Operations Management and Systems Management, as well as courses in user-related fields such as Banking, Finance, Health Services, etc.

Information Technology Organizations

3. Association for Computing Machinery (ACM)

The ACM was founded in 1947, to:

> *advance the science, development, construction, and application of the new machinery for computing, reasoning, and other handling of information.*

Although this definition has changed as information technology has evolved, it reflects the breadth, depth and academic orientation of ACM's focus. These areas of interest overlap such fields as mathematics and electrical engineering, and ACM has worked with professional organizations in these fields since its founding. Education and professional development have always been primary objectives of ACM, and its program has included publishing journals and literature reviews, presenting seminars, and developing curriculum recommendations. The strong academic component of its membership assured that these efforts were all of high professional standard, and accepted as authoritative in the industry.

4. Data Processing Management Association (DPMA)

DPMA was originally known as the NMAA (National Machine Accountants Association), and was originally an association of supervisors of tabulating (accounting) machine operations. With the introduction of computers into the world of accounting, NMAA members found that they must either upgrade their skills or be displaced. NMAA therefore took 2 steps in 1962:

- changed its name to DPMA as a signal of its change of emphasis/direction
- created a test and certification program for data processing (the original "DPMA Exam").

At the time, no one else had a certification exam in any aspect of data processing or computer science and there was little curriculum development in this area. Therefore, the DPMA exam essentially defined an area of knowledge as well as certifying people in this area. Given the background of DPMA (ex-tab machine operators), the focus was primarily on commercial data processing, rather than on computer science or information technology.

5. (Links Between ACM/DPMA and Other Data Processing Associations)

Because its traditional membership was generally less-well-educated, lower-level managers in smaller organizations, DPMA never came to have the stature it desired. Instead of joining DPMA, senior data processing managers in large corporations formed the Society for Management Information Systems (SMIS) in 1968 to further their interests. The business and data processing-oriented focus of SMIS also attracted academics who could not find support for their interests in the computer science-oriented Association for Computing Machinery (ACM).

By the early 70s, many members of ACM, SMIS and other computer-related professional organizations such as IEEE (Institute of Electrical and Electronic Engineers) felt the need for more standardized definitions of computer-related knowledge and a clearer process for establishing the qualifications of individuals in the field. At the same time, the DPMA Certificate was losing credibility as the DPMA continue to decline in relative importance compared to ACM, SMIS, etc., and the knowledge base of computer science and information technology expanded beyond the range of interests of DPMA and its membership.

This combination of factors led to the creation of the Institute for Certification of Computer Professionals (ICCP) in 1973. ICCP took over responsibility for the old DPMA exam and expanded its scope to cover more details of computer science and engineering-related knowledge. The governing body of ICCP was composed of representatives from DPMA, ACM, IEEE and several other organizations; there are now 14 organizations on its Board.

6. EDP Auditors Association (EDPAA)

The EDPAA is the only professional organization dedicated to EDP auditing. Within this program are represented many disciplines including data processing, accounting, management, data security and quality assurance. Currently EDPAA has over 9,000 members worldwide, and of these about 5,000 have been certified as Certified Information Systems Auditor (CISA). EDPAA has over 114 chapters worldwide. There are monthly meetings, a national conference held annually and several world conferences are also held. The organization also holds seminars, gives independent courses and is responsible for administering the CISA examination program at over 100 locations worldwide. CISA exams are given once a year usually in the spring.

In order to qualify for the CISA candidates must have a minimum of 5 years of EDP or EDP auditing experience. The candidate may substitute college background for some of the experience requirement. Finally the candidate must pass an eight hour multiple choice exam in the subject. About 52% of examinees pass the exam on their first try. The exam covers 11 areas of knowledge including application systems control, data integrity, systems development life cycle, maintenance, security,information systems audit management, etc.

The CISA program is administered by a test maintenance committee who utilize subject matter experts worldwide to generate questions. These subject matter experts themselves are CISA holders. There is a recertification program that requires each CISA holder to present evidence of 120 CEU every three years to maintain their CISA. Statistics on member qualifications, examination results, and test questions are maintained by EDPAA.

7. Institute for Certification of Computer Professionals (ICCP)

The ICCP, an umbrella organization for some 14 professional societies in the U.S. that is involved in the Data Processing disciplines was somewhat apprehensive about participating in a study that directly impacts some of the work that they are involved in. In particular, ICCP offers a certification program that from their point of view is very similar to that being offered by JITEC. In addition, ICCP programs are worldwide in scope. Therefore, they feel that there is overlap in the JITEC program and the work they are engaged in.

At the present time, ICCP has not yet agreed to respond to the questionnaire. One of their concerns, aside from the potential overlap of activity, is that they are not convinced they will receive any benefit from the extensive staff work they believe will be necessary to complete the questionnaire. At this point, INPUT believes that ICCP should be interviewed on a personal and direct basis. When JITEC staff visit the U.S., it should be possible to set up direct discussions between the two groups. In an open and frank dialogue, we believe these difficulties can be overcome.

8. Office Automation Society International (OASI)

OASI is an example of a relatively new organization. It was founded in 1981 and currently has about 1,000 members. Currently membership is open to individuals who have three years of relevant experience and who pay an annual membership fee of $85. The major benefits of membership in OASI are a newsletter which appears about twice a month, an annual meeting that covers developments in the office automation field, and a certification program that is offered to qualified individuals.

The certification program has been in place for about three years. Presently about 900 people have been certified. Since the field of Office Automation is so diverse, to date the program has been primarily based on work experience with some educational requirements. Each applicant completes a detailed application which outlines work experience and education. OASI is currently working on developing an examination procedure, but this has not yet been finalized.

Once certified, the credential must be renewed every three years. Members of OASI pay a fee of $135 and nonmembers pay $185 for the process. The same fee schedule applies to recertification. OASI is planning on replacing the current grandfathering program with an examination procedure in about a year. OASI will be setting up a National Board of Examiners selected from the Certified Office Automation Professionals. This group will develop the examination. The plan will then use an national testing organization to administer and evaluate the test results.

OASI is loosely associated with the Association of Information Systems Professionals (AISP). This sister organization is also composed of individuals in the office procedures field. AISP has about 5,000 members. The executive Director of OASI, Paul Oyer, is also an officer of AISP.

Other Professional Organizations

9. American Institute of Certified Public Accountants (AICPA)

The AICPA has been responsible for administering the uniform examination for CPAs since 1915. Exams are given twice a year, in May and November. Approximately 65,000-75,000 candidates take each exam. The CPA program is considered a two tiered program. A person who passes the CPA exam is granted a certificate by the AICPA and a license to practice from a state licensing board. A state may require additional experience and education beyond passing an examination to be licensed.

The exam is an open book exam, and previous exams and answers are sold to candidates. These can be used for review purposes. Currently each exam is composed of 60% multiple choice and 40% essay questions. The AICPA publishes a candidates guide to the examination which takes about 19 1/2 hours over several days to complete. The exam is composed of five parts, Accounting Practice Part 1, Auditing, Accounting Practice Part 2, Business Law, and Accounting Theory.

The AICPA is responsible for developing each examination, making changes to the testing program, statistical analysis and grading. AICPA has subject matter experts that work with the subcommittees that have been put in place for each part of the exam. Once the parts of each exam are developed, the full Board of Examiners approve the final form of an exam. As new accounting procedures are developed in the field, these new procedures work themselves into future exams. This means that exams are very current, and simply reviewing old exams and answers does not guarantee success in taking current tests.

10. Educational Testing Service (ETS)

ETS is the premier organization in the world for the development and marketing of specialized testing programs. Its basic mission is to provide tests and related services, as well as research and other activities that meet the assessment needs of the educational community. ETS activities cover a broad range of educational needs from primary school through university graduate school, and they are well known for the many examinations that they administer to the college and university market to assess student capabilities.

ETS has also been very active in statistical analysis of educational programs and tests. In many cases ETS has pioneered new and innovative testing techniques that should be of interest to JITEC in its future plans. The techniques that ETS has developed over the last 40 years for test assembly, reuse of questions, question construction, bias analysis, and statistical analysis of candidates and test procedures, are of course vital to anyone working in the field of professional examination programs. In addition, ETS is in the forefront of planning and thinking about the introduction of new technology and use of computers for testing. INPUT believes that any future work that JITEC is planning can only be enhanced by sharing views between the two organizations, JITEC and ETS.

Since there is some competition in the world for the applications that they market, they feel a natural reluctance in discussing some of their "proprietary" ideas and programs with others. While they have provided valuable literature which describes their activities, including reports, studies, etc. on individual fields of testing, they felt that the questionnaire was inappropriate to their broad range of activities and the large and diverse testing programs they conduct.

Since they are so involved in programs that relate to the kind of activities that are of concern to JITEC, INPUT feels that, as with ICCP, a face to face meeting between both groups would be useful. In a frank and open discussion of JITEC interests, with assurances to ETS regarding the preservation of their assets, there is much that would be gained from such a meeting.

11. Institute for Certification of Tax Professionals (ICTP)

The Institute for Certification of Tax Professionals was started by Robert Verkler, a Professor at California State University -- Los Angeles (CSLA). Within the State University system, CSLA had an excellent reputation as a school of Business, with a speciality in taxation. As its reputation in taxation grew, more people looked to CSLA as a source of consulting, curriculum advice, etc. Although there were a number of standard curricula and certification/licensing programs in related fields (e.g., law, accounting), there was no set of standards defining knowledge or competence in taxation. ICCP was started in response to the increasing complexity of taxation and the corresponding needs for education standards and some evidence of competence in the field.

12. Institute of Chartered Financial Analysts (ICFA)

The ICFA is a professional organization composed of members called Chartered Financial Analysts (CFA), who are engaged in the practice of financial analysis, who have completed a three year study and examination program. ICFA currently has about 12,000 CFA members and another 10,000 members who are in various stages of being certified. Members of ICFA normally work for institutional investors, pension plans, mutual funds, banks and securities firms.

In order to qualify as a CFA a candidate must show evidence of three years of relevant work experience, possess an undergraduate degree and pass three examinations. The exams are progressively more comprehensive and more analytical (require more synthesis on the part of the examinee). The exam covers seven topics. These include professional ethics, accounting, economics, quantitative analysis, equity securities analysis, fixed income security analysis, and portfolio analysis.

Approximately 7,000 candidates took the three parts of the exam in 1988. Of these about 60% passed the various parts. Each part of the exam takes 6 hours and the tests are give once a year in June. Each test is composed of a small number of multiple choice questions and larger number of essay type questions. Samples of some of the more recent tests have been provided to INPUT by ICFA and are available for review by JITEC.

The CFA program is international in scope. About 25% of the CFAs are Canadian with another 15% outside of North America. The CFA program has been growing about 20% a year over the last six years. The tests are administered at over 100 locations worldwide. The ICFA offers seminars and classes to prospective candidates worldwide. Currently there is a voluntary program for continuing education for CFA holders. The organization is looking into making this a mandatory education requirement for recertification. Although the interest in the CFA program is growing and the importance of the CFA is increasing, the industry has not established a uniform requirement for it for employment, but the feeling of the organization is that is the direction that appears to be gaining.

Each annual examination is prepared by an examination committee from the ground up. Since there is a tremendous amount of material that is new each year, the feeling is that all material needs to be reexamined and a topical exam has to be prepared. There are study and exam committees that constantly review the sections of the exams and the kinds of questions. A candidate curriculum committee is responsible for preparing syllabi for the exams, which are then sent to candidates to study from.

13. Institute of Management consultants (IMC)

The IMC is the sole credential organization for consultants in the United States. There are currently about 1550 full members in IMC and another 600 associate members. Associate members are those who have not yet been fully credentialed, but are in the process of becoming credentialed. A full member in IMC is entitled to be called a Certified Management Consultant, and can put CMC next to his name on business cards. IMC was formed in 1968 and came out of a smaller group called the Association of Consulting Management Engineers (ACME). ACME is an organization composed of 60 consulting firms active in the field such as Arthur Andersen, Peat Marwick Mitchell, etc.

One of the major purposes of the IMC and its credential is to provide industry a place to go to find consultants who have met strict professional requirements and standards, who subscribe to a code of ethics and who can instill some degree of confidence in the abilities of its members.

The IMC offers a full program of seminars that are used by associate members to prepare for regular membership. In order to qualify for the CMC candidates must present 5 years of acceptable management experience, letters of recommendation from 6 clients, an undergraduate degree, personal letters of recommendation, sit a written examination, and finally an oral interview by a panel of CMC holders. The entire process takes about one to one and a half years to complete.

Since the IMC utilizes such a comprehensive process in order to qualify for the CMC, it represents an extremely valuable and recognized goal for consultants. IMC currently receives about 1500 requests from organizations who wish to utilize consultants and are looking for referrals. IMC monitors its members very closely, and requires strict adherence to its code of ethics.

The examination itself is composed of two parts. It is a practical exam that utilizes multiple choice questions to cover practical questions, and essay questions to test analytical abilities. Questions are generated by consultants and practitioners in IMC.

14. National Association of Securities Dealers (NASD)

NASD is the association of companies that market securities in the United States. There are some 6,000 member firms in NASD. NASD is a self regulating organization that was set up under the Securities and Exchange Regulations of 1934. Under the rules any individual who sells securities for any member firm must first pass a series of examinations which then qualifies that individual to market securities under federal laws. About 246,000 individuals took these registration examinations in 1987. In addition NASD prepares examinations for other groups. For example NASD supervised about 12,000 examinations for commodity traders and about 8,000 examinations for state securities commissions in 1987.

Each member firm is responsible for the training of their employees prior to taking the national examination. Today these tests are given in 65 cities in the U.S. where there is a member firm. Candidates can take these exams on computer terminals at anytime. There is no set date for examinations. Since they are computer based, the examination is administered in real time whenever a candidate appears at a terminal. In addition since there is a large centralized computer servicing all candidates simultaneously, examinations are created at the instant the examinee takes the test, and no two tests are the same. That is, each test is created in a random fashion.

Among the unusual features of this NASD approach is a real time statistical analysis which is done as each question is generated to ensure fairness and uniformity toward each examinee. The system is built around the Plato tutorial system developed by the Control Data Corporation and has been in use since 1979. NASD has set up test committees to review and update tests and questions to guarantee accuracy and timeliness.

There are many subspecialties that these tests cover. Included among these are mutual funds, life insurance, municipal bonds, corporate bonds, limited partnerships, and options trading. NASD takes an active interest in their testing program, and currently there are committees that are looking into training standards, and continuing education requirements.

15. National Board of Examiners in Optometry (NBEO)

In contacting the NBEO for inclusion in this study, INPUT was fortunate in reaching Dr. Leon Gross, Director of Psychometrics and Research. Dr. Gross is very knowledgeable on both the examination program as well as the statistical analysis procedures. The NBEO has been in existence since 1951 and plays a key role in developing a testing procedure, and ensuring that these examinations are both comprehensive and relevant to the field of optometry.

Currently about 1,000-1,200 students a year take NBEO examinations. Examinations are given twice a year, in April and August. In order to take exams, the candidates must be either graduates or students in the 16 accredited schools of optometry in the United States. Although licensing of optometrists in the United States is a state responsibility, NBEO works closely with each of the state licensing boards. Currently, 45 states use the NBEO examination as part of a licensing procedure, and 5 states do not use the examination in their licensing program.

The NBEO takes its examination program quite seriously. There are several committees charged with responsibility to review the program and its effectiveness. As conditions warrant, changes are made. For example, in 1980 an external review committee was setup to review the entire examination program. Some 39 recommendations were made, and many of these have been incorporated in the revised program that is in place today.

The current examination program includes three examinations that are given to candidates during and after their attendance at the Schools of Optometry. The first, or Basic Science examination is targeted to students who are in their second year of optometry school. The second, or clinical science examination is aimed at students who are completing their third year of schooling. NBEO is planning a third examination for introduction in 1990. This will be a patient care examination for graduates in practice.

The testing program is currently oriented around multiple choice questions. The purpose of the patient care exam is to require more practical day to day knowledge and apply this to actual patient situations. Dr. Gross has been very involved in examining the efficacy of the testing program, its objectivity, and techniques to confirm the value of the program as a evaluation mechanism.

One of the techniques that is highly prized by NBEO is the test critique procedure that has been introduced. Students taking any exam are encouraged to submit with the exam a test critique form that notes possible ambiguities or specific quality issues about particular questions that a student may identify. These forms are forwarded to the proper examination development committee for immediate review. Students get rapid response and the committee can determine ambiguities and take corrective action in the scoring process.

There are well over 1,000 practicing optometrists as well as faculty of the various schools nationally who are involved in generating questions for the program. NBEO maintains a computerized test bank into which questions are placed, and from which examinations are developed.

Several booklets and guides have been developed by the NBEO that are useful to both examination candidates and question preparers. Samples of some of these documents are included in the material developed for JITEC.

16. National Institute for Certification in Engineering Technology (NICET)

In contacting NICET, INPUT was fortunate in being able to discuss the programs with the general manager, Dr. John Antrim. NICET is an umbrella organization that administers a very comprehensive program that covers a very broad range of disciplines. There are many technical fields where engineers of one sort or another work. Many of these professions require technical workers who do not require either the educational knowledge or technical skills of engineers, but a high level of technical knowledge peculiar to that discipline. NICET was set up over 25 years ago to measure, identify and certify the knowledge base for technicians and technologists in over 30 different programs. In many of the programs NICET administers, states require NICET certification for actual employment. In other programs candidates use the certification process for promotions or bonuses, or recognition.

To date over 75,000 technicians have been certified and over 600 technologists have also been certified. Technologist is a designation that refers to a graduate of a 2 or 4 year applied engineering program at a college level. Examples of certification programs that NICET supports are highway construction, highway design, highway surveys, building construction, industrial instrumentation and fire protection.

Currently examinations for the various programs are offered 4 times a year at over 120 locations nationwide. All of the examinations are multiple choice in makeup. There are no specific educational requirements needed to take NICET examinations. Generally each discipline offers testing in three categories. Candidates start with an entry level certificate exam. After this is passed and after a sufficient number of years of work experience the candidate takes a middle level certificate exam, and finally after more experience (usually 10 years) the candidate can take a senior level examination. Individuals progress through various levels of certification during their careers that is a function of both time (work experience) as well as passing tests.

The testing procedure itself is somewhat unusual. Each test is tailored and created by the candidate. That is a candidate determines what credential he is applying for and chooses a series of modules that apply to that specific credential. For example if he is seeking a credential in civil engineering technology, he selects a general examination which tests communication skills, mathematics, and science, and then picks half a dozen other modules from a list that has highway design, mapping, drafting, surveying, pilings, soils analysis, cost estimating, etc., as choices. This technique of testing means that if 30 people have selected civil engineering technology as their field of specialization, and are taking the test in one location, there could be 30 different modules of tests selected by the candidates.

As technology changes and new specialties are developed in industry, NICET is called upon to introduce new programs. There are new programs being developed all the time. NICET works with either the professional society closely related to the subject, or with state boards of interest or with employers who may be interested in programs. Examinations are all open book and NICET provides guide or manual to candidates for each of the programs they offer.

Examination questions and modules are developed by experts in the specific field. These people come either from industry or the professional societies directly involved in the technology.

17. Professional Examination Service (PES)

It was not possible to conduct the standard oral interview with this organization as they were in the midst of annual meetings and preparing for conferences with their Board of Directors. However, in response to our interview request, they provided us with a set of background material describing their capabilities and procedures. In addition, they indicated that, if at some time in the future JITEC would like to talk to them about specific programs or issues, and what further information they might be able to contribute to this study, they would be available and willing to cooperate.

PES performs testing services for professional, governmental and industrial clients, and has several nationally prominent experts in the assessment field on its staff. PES offers a full line of basic testing services, including:

- program planning and consulting
- test development and validation
- examination printing
- test administration
- scoring and statistical analysis

In addition, they provide administrative and other services to support the overall needs of a professional certification program. Among these services are:

- candidate application review and processing
- self-assessment methodologies for support of continuing education
- other complimentary assessment methods such as simulations, in-basket management, memo-writing exercises, etc.
- database management systems to maintain candidate records, including demographics, examination history, continuing education, and other credentialling information.

To provide this comprehensive service, PES operates a large and sophisticated computer center. Computerized question banks allow rapid generation of new exams, multiple versions of exams, statistical analysis of questions and exams, and other types of analysis such as correlation of candidate demographics (education, experience, etc.) with test performance.

One of the things which PES prides itself on is the practical, career-related nature of the tests it develops. In order to ensure that examinations are job-related (i.e., content-valid), PES has developed specific methodologies for "role delineation" -- definition of job duties, and the knowledge and skills required to perform these duties. In a typical situation, committees of experts in a field are convened in workshops to identify tasks, rate their importance, identify the skills required to perform the task, etc. Questions are then developed in carefully managed item-writing workshops, where experts in the field are instructed in the procedures for construction of test questions, including proper wording of distractors, etc. This ensures that the items are both current and relevant, and also properly structured for effective discrimination among candidates.

IV

Future Trends in Information Technology

IV Future Trends in Information Technology

The future components of information technology may be organized into five categories, as follows:

- Independent Processors
- Embedded Processors and Other Associated Hardware
- Networks and Communications Systems
- Software
- Public-Interface Systems

This chapter discusses likely trends in each of these areas. As part of the continuing process of developing the ITEE, JITEC should monitor these trends and update this outline at least every 2 years. The outline can then be used to guide development of specific questions covering each of the evolving areas.

A

Independent Processors

The current major categories of processors will persist for at least the next 10 years:

- Supercomputers
- Mainframes
- Minicomputers
- Micros/workstations

Two additional categories of specialized machines will emerge as separate and important markets:

- Fault-tolerant transaction processing machines
- Data base machines

These machines will have architectures and operating systems optimized for their particular function. There will also be a tendency for these two capabilities to merge, as large-scale database machines become used for storing/updating the data used by on-line transaction processors.

Minicomputers will tend to decline as general purpose machines, being squeezed from the bottom by micros/workstations and from the top by mainframes. They will give way to special-purpose machines in the fault tolerant and data base areas.

Definitions and characteristics of each of these machines are provided below.

1. Supercomputers

These machines are generally used for massive scientific calculations. They typically combine extraordinarily large memories and super-high-speed circuitry with specialized processors for vector/parallel/etc. processing. Future supercomputers will probably come in two types:

- Super-high-end, like Cray; maximum possible performance for maximum price
- "Mini-supers" with the same basic virtual capacity (address space, vector/parallel processing, etc.), but using slower speed circuitry (based on older technology) at much lower cost

2. Mainframes

These machines are the large-scale central data processing (vs. scientific processing) workhorse of most companies and come in a wide variety of capacities. Connec-tivity is going to become increasingly important here, and many such systems will probably shift more toward being data switches and distributed data base managers than monolithic central data repositories. This evolution will be slow because IBM is not expected to enthusiastically support it.

3. Micros/workstations

These machines place storage and computation power at the desktop of the user. In the future, they will:

- continue to come in a wide variety of performance ranges for different needs
- increasingly be networked (both locally, to other local nets, and to/through mainframes), with upper-end models being used as servers in local-area networks
- also provide connectivity to mainframes for data access, either to data on the mainframe or via the mainframe as a switch to other locations in an information network
- have increasingly user-friendly operating system software

4. Fault-tolerant transaction processing machines

These machines provide specialized control of on-line processing. Conceptually, this control includes all phases of processing, from remote terminal drivers (e.g., ATMs) through communications control/switching to applications management. These may interface with a number of other systems, both upstream (remote devices and networks) and downstream (data base machines, distributed data bases). They will reside in the center and control the overall process on a self-analyzing, self-repairing (i.e., fault tolerant) basis.

5. Data base machines

These machines are specifically optimized for rapid, random access to massive data bases. Most future machines will likely be patterned after Teradata's model of massive parallelism in processors and storage units. They may be driven directly from networks of local processors, or function as a file server for mainframe applications. Data base machines can be easily linked with transaction processing systems and monitors (Tandem/Stratus, or IBM TPF) and configured for fault-tolerant operations if desired.

B

Embedded Processors and Other Associated Hardware

Computer chips will be embedded in more devices for control purposes, ranging from consumer products to appliances to vehicles. Most electro-mechanical devices will become smarter, with personal customization as a key feature.

User interfaces (both hardware and software) will also improve significantly, as more on-board logic is placed in the workstation and other terminal devices. Included will be capabilities such as:

- voice recognition
  - limited vocabulary, wide range of speakers
  - broad vocabulary, customized to specific individuals
- voice synthesis
- touch-screens
- sophisticated "help" functions

Graphics capabilities will improve markedly at reasonable cost, with significant advances in:

- terminal resolution and color
- laser printers (including color)

Finally, image processing systems will become affordable for many applications, based on the following combination of factors:

- availability of cheap optical disk storage (read and write)
- high-speed logic chips for image recognition/digitization/display
- high-resolution displays (both terminals and printers)

C

Networks and Communications Systems

ISDN technology will make local networks easier to develop/manage, but create new challenges for telecomm specialists who must contend with a mix of older private networks and newer ISDN offerings by communications utilities. ISDN growth is expected to be slow rather than fast.

Existing delivery channels (satellites, optical fibers, etc.) will continue to grow in capacity and quality and current public and private network traffic will continue to grow as well.

Interchange capabilities between carriers will be increasingly demanded by users and mandated by governments. This will create new demands for standards (both for users and utilities), and interchange agreements between utilities. Affected vendors will include PTTs and VANs.

Electronic Data Interchange (EDI) will grow at a very rapid rate as the costs of manual transactions increase while the costs of automated transactions decrease.

Users will increasingly demand standards for such things as EDI, and more active work will occur in this arena. Trade associations will help drive these trends.

Value-Added Networks (VANs) will increase in importance as special purpose connections/translators between companies (e.g., for EDI or FAX networks). To a lesser extent, systems integrators will use them as connections between different systems of the same company. By contrast, their importance in providing "pure connectivity" (i.e., connections without specific added value) will decrease as more vendors as well as more technological approaches to connectivity appear in the market.

Local area networks will become increasingly important in departmental automation strategies. Functional servers based on micro/mini/workstation or database machine technology will be connected to these networks to provide support as needed. In addition, these networks will be connected through communications servers to other networks and centralized corporate mainframe systems.

D

Software

Software may be organized into the following categories

- operating systems and systems utilities (e.g., MVS and CASE tools)
- utility applications packages (e.g., spreadsheets, graphics, word processing)
- applications programs

Although there will be evolution in all three areas, the changes in the operating systems/systems utilities area will be the most significant, as it is these changes that provide advanced tools and capabilities for development of applications programs.

Changes in applications utilities are also important, because they will increasingly be employed by end users as an alternative to individual custom applications programs.

1. Operating systems and systems utilities

Operating systems will generally become more internally complex and more user-friendly. At the mainframe/supercomputer level, the need for operations staff will decrease as "lights-out" data centers become more of a reality. In addition, it will become easier to control complex mixes of hardware/jobs/etc. as operating systems standards converge (e.g, TSO/MVS/VM approaches to tape mounting, operator communications/ messages) with increasing automation of data centers.

At the micro/workstation level, capabilities that are on the forefront of today's systems will mature and make life easier for users (windows, touch-screen operations, icon-based menus, etc.).

UNIX will likely emerge as the first portable operating system to achieve equal market standing with proprietary operating systems (e.g., MVS, VM, VMS). The current split between the ATT UNIX group and OSF is expected to disappear, and a single UNIX standard will prevail.

In addition to UNIX and the Pick Operating system, a number of other standards will be developed or expanded to allow greater interchange of data between old and/or dissimilar systems. Many of these standards are now being developed by Sun Microsystems, the Corporation for Open Systems, etc.

Building on these other standards, proprietary operating systems and/or standards (such as SNA, DCA, SAA, and SQL) will increasingly converge on one another, or become adopted as de facto standards and supported/interfaced by a large number of vendors.

Hardware interfaces will continue to become more open and standardized, and there will be more cooperation between hardware and software vendors in developing joint standards such as the Lotus/Intel/Microsoft memory expansion board.

Ada will emerge as the primary development language for new U.S. government mission-critical systems. Its commercial acceptance and use will be slower in the U.S. than in other countries.

C language will emerge as the primary development language for operating systems, systems utilities and application utilities.

COBOL will play a declining role in new application development, but maintaining the installed application base will go on for the next 20 to 30 years.

The trend toward specialized new application development languages (4GLs) will continue and saturate toward the end of the 10-year period.

FORTRAN, or a FORTRAN-like language, will continue to be used in scientific processing. The language will also continue to be refined to support vector/parallel processing via automatic program analysis (the compiler determines when/where parallel processes can be initiated, where they must be joined, what calculations can be done in vector modes, etc.); this work will be done largely by supercomputer manufacturers.

CASE tools will add significantly to the speed and quality/accuracy of newly developed systems. Coupled with this development will be the increasing use of artificial-intelligence-based tools such as decompilers and applications analyzers that will be used to maintain/translate/convert old applications written in COBOL and assembler.

2. Utility applications packages

Utility applications packages (e.g., for spreadsheets, word processing, graphics, statistics, etc.) will gain increasing capability and be used with increasing frequency across all types of platforms. Different functional capabilities will still be provided by different packages/vendors (the grand dream of an integrated system like Symphony will not be realized), but standards for information organization and interface (including Hypertext) will allow the rich and easy combination of work from various utilities into a single presentation-whether a document, a screen interaction, etc.

In a manner paralleling CASE tools, CAD/CAM tools will speed the hardware design process, making it cheaper/easier/faster to create customized chipsets for new products, including embedded process control chips for machines, etc.

Data bases will increasingly be structured using the relational model. This will put additional demands on users to understand the relational model, as opposed to hierarchical or flat file models.

E

Public-Interface Systems

More applications will be automated to the extent of direct public interface with systems such as ATMs. In general, consumer retail activities will be much more highly automated, in a variety of ways, both for the consumer and for the vendor:

- access to tickets/reservations will be provided via ATM-like reservations systems/ticket dispensers
- on-line credit checking/account debiting will be provided at point of sale (POS)
- inventory management will be significant improved with on-line capture of product movement at retail POS

Interactive Videotex will grow slowly in consumers' homes, despite the great push of its proponents, for three main reasons:

- the cost of sufficient quality output to make it attractive (e.g., $6K+ for the graphics quality of Steven Jobs' new NeXT machine) will continue to be prohibitive for some time
- most people have a psychological resistance to electronically handling consumer transactions in their homes -- it seems unnatural somehow, and people like to look at catalogs
- data path bandwidths required to do anything more than annoyingly slow and primitive displays are only available via TV cables; ordinary phone lines have insufficient bandwidth

By contrast, Videotex combined with optical disks has good potential as an information and advertising medium in sales offices (e.g., real estate brokers, banks, catalog outlets), shopping centers, airline terminals, etc., where the traffic level is sufficient to justify the high fixed cost per display unit.

Consumer use of Smart Card technology will grow slowly, due to high cost of:

- preparing cards for consumer
- installing smart card readers in merchant locations

Additional constraints on consumer smart card use include the risk associated with loss or defect of the card if it has either built-in funds or contains transaction or other records which would be difficult or impossible to recreate.

V

Future IT Knowledge Requirements

V Future IT Knowledge Requirements

With the increasing domination of modern life by Information Technology, it is not only the IT professional that must know how to apply these tools; end users also have specific knowledge requirements which must be met if they are to make effective use of the applications developed by IT professionals. Also, increasing numbers of end users are applying utility applications software (e.g., word processing, graphics, spreadsheets, etc.) to their daily tasks.

In addition to end users, there are two separate categories of IT professionals:

- Application developers/maintainers
- Developers/maintainers of hardware and software systems

Applications development professionals are primarily focussed on implementation of specific user-oriented applications. Their knowledge requirements are heavily oriented towards *using* tools -- hardware, software, utilities, etc. -- to solve the user's problem. In addition, they must know how to analyze the user's requirements and design a system which is implemented through these tools.

By contrast, developers and maintainers of hardware and software systems are primarily tool *builders*, supporting the requirements of the applications developers.

Each of these groups has unique knowledge requirements, all of which are addressed here.

The first part of this chapter focusses on the knowledge requirements of end users. The second part addresses the requirements of applications developers, while the third part address the developers and maintainers of hardware and systems.

It should be noted that the knowledge requirements outlined here are based on the U.S. environment. To the extent that there are specific differences between the U.S. and Japanese markets (e.g., in the structure of the telecommunications industry), these recommendations must be adjusted to fit local conditions. For example, references to AT&T and RBOCs (Regional Bell Operating Companies) must be considered in light of their Japanese market equivalents (e.g., NTT).

A

End Users

End users may be divided into three categories, based on the nature of their work and the amount of IT knowledge they require to perform their jobs. These categories, and their associated knowledge requirements, are described below.

Level I End User

The lowest level of end users are people such as data entry clerks or bankers opening an account. These users do not need to know anything about computers, just the application. No prior training is required since they will be trained on the application itself by their employer.

Level II End User

These are people who use utility applications software (e.g., spreadsheet/graphics/ desktop publishing applications). These people work with the tools, but do not write code or develop applications. They must know the concepts underlying the tool (e.g., what is a spreadsheet), and the *use* of the operating system and its utilities (e.g., how to copy and delete files, print data, etc.). Examples of their specific knowledge requirements are:

1. **Hardware Concepts**
   - System components: Display, keyboard, processor unit, printer, disk storage, modems, trade-offs and performance

2. **Software Concepts**
   - Operating systems, e.g., MS-DOS, PC-DOS, OS/2
   - Utilities
   - Programming language-compilers/interpreters
   - Applications (self-developed; packaged; turnkey)
   - The role of the operating system
   - Concept of directories
   - Preparing a disk for use
   - Making additional copies of files
   - Creating/removing a directory

3. Spreadsheet Concepts

- Understanding key spreadsheet features
- Creating a spreadsheet
- Designing and using a template
- Understanding "What If" analysis
- Graphics-getting your point across through quick and flexible display of data
- Building and viewing graph
- Transferring data from other software packages to a spreadsheet

4. Database Concepts

- Introduction to databases
- What is a database, structuring a database, typical applications
- Terminology-field, record, file
- Creating a database file
- Managing a database file

5. Word Processing Concepts

- Text creation, formatting functions
- Editing and printing functions
- Word processing package functions

6. Presentation Graphics Concepts

- Overview of available options

Level III End User

Examples of Level III knowledge requirements are:

1. **Hard Disk Mangement**
   - Fixed disk setup and use
   - Partitions/multiple operating systems
   - Tree-structured directories/subdirectories
   - Wild card search and processing

2. **Integrated Components**
   - Spreadsheet
   - Data management
   - Graphics

3. **Basic Features of Utilities**
   - Cusor movement
   - Types of data (variable, constants, addresses, tags)
   - Formatting information (numbers, dates, alpha)
   - Writing formulas
   - Writing process/control procedures
   - Input/output commands
   - Linkages with other applications/utilities/operating system

4. **Advanced Database Concepts**
   - Hierarchical, network, and relational models
   - Logical data structure representations
   - Data description languages
   - Query facilities
   - File and index organization
   - File security
   - Data integrity

5. Database Functions

- Creating
- Sorting
- Selecting/extracting/merging
- Query

6. Graphic Functions

- Selection of appropriate graph types
- Display/appearance options
- Output options

7. Macros

- Definition/concept
- Simple macro development
- Macro writing (language/syntax)
- Invoking/stopping a macro
- Debugging macros
- Documentation/reuse of macros
- Writing a Menu; loops/submenus/returning control to the user
- User help screens/auto-loading macros

8. Advanced Utility Application Usage

- Planning for growth
- Efficient memory management
- Planning/design of worksheets/databases
- Integrating/linking multiple files/databases/spreadsheets

B

Application Developers/Maintainers

This section covers the knowledge requirements of people who develop end-user applications. Two macrotrends are of interest. First, the high cost and time-consuming, labor-intensive nature of application development has created the need for tools and technology that improve the efficiency of software design, coding, testing, and maintenance. Second, with the increasing popularity of application products, data processing organizations must learn to support the new and diverse technology imbedded in them (e.g., 4GLs, expert systems, etc.).

Gradually replacing the traditional programmer, programmer/analyst, and analyst categories of application development and maintenance personnel is the following:

Function	Description
Applications Analysts	Translate company needs into application requirements and specifications
Technicians • *Programmers*	Write, test, and maintain code
Technicians • *Data Management*	Assure consistent and optimal database design and maintenance
Technicians • *Telecom specialists*	Assure appropriate network functionality and operating support for the application

1. Applications Analyst: Knowledge Requirements

1.a. Systems Analysis

- Establishing a framework for successful systems-ground rules, standards, training, problems
- Structured Tools -- how they work, data flow diagrams, data dictionary, process logic, data stores
- Data flow diagrams -- symbol and explosion conventions, error and exception handling
- Data dictionaries -- contents, inquiry features, data models
- Tools for expressing logic -- decisions trees, decision tables, tight English, structured English
- Data stores -- a logical form of data expression
- Using Structured tools to
  - develop a current logical model
  - develop system proposals/physical models
- Understanding the use of structured walkthroughs
- Structured design considerations

1.b. The System Development Life Cycle Approach

- Principles of systems development -- problem solving, a phased approach
- Project initiation phase -- problem definition, cost benefits, feasibility study, interviewing skills, data gathering, data flow diagrams
- Analysis phase -- study the current environment, define resources, alternatives, data flow diagrams, data dictionary, process logic
- Design phase -- derive a physical design, hardware, software, and data requirements, user/systems interface, prototypes, system specs, data modeling, structure charts, pseudo code, system test plans
- Development phase -- program specs, screen and report layouts, test cases, database development, conversion, user/system documentation
- Implementation and delivery phase -- system installation, user training/acceptance, post-implementation, maintenance
- Project management -- estimating, planning and scheduling the project, automated systems
- Automated systems analysis tools -- demos and literature describing the latest products available and what they can do

1.c. CASE

- MIS perspective on application software -- problems/expectations/solutions
- User perspective on automated systems -- problems, expectations, and solutions
- CASE project life cycle
- CASE workbench of tools
- Classification of CASE products
- Installing a CASE product and its supporting methodology

2. Technicians -- Programmer: Knowledge Requirements

2.a. Computer Equipment and Function

- Internal functions of central processor unit
- Storage devices: Primary and secondary
- Peripheral devices: data collection, reporting
- Computer configurations
- Comparisons of hardware components

2.b. Programming Languages in Organizations

- Compilers, interpreters, assemblers
- Generators, file management languages
- Languages relative to equipment
- Languages appropriate to the application
- Mode of processing: demand versus batch

2.c. Computers in Organizations

- Evaluation of computers and their usage
- Computer center in the overall organization structure
- Computer centers: structure, staff, job descriptions
- Relationship of programmer to the computer center organization
- Statistical data and trends
- Costs: hardware, software, other

2.d. Overview of an Existing Applications System

- Necessary reports
- Source data
- Systems flowcharts
- Process flowcharts
- Necessary programs
- Equipment/configuration needed
- Proper documentation of usage of the system

2.e. Overview of the Systems Cycle and the Programmer's Role in the Project

- Analysis phase
- Development phase
- Implementation phase
- Production phase
- Evaluation phase
- Program maintenance

2.f. Documentation

- Using systems documentation
- Using systems flowcharts
- Using flow process charts
- Evaluation of program documentation

2.g. Data Elements and Files

- Collection, forms, and coding
- Mode and format
- Data validation and control: mode checking, limit checking, consistency between elements, check digits
- File validation and control, internal labels, external labels, file backup, hash totals, batch totals
- File structures
- File security and techniques
- Concern for privacy

2.h. Report Requirements and Forms Control

- Survey of business forms
- Input forms: types, evaluation, development, control
- Output forms layout
- Output forms: distribution and control
- Programming considerations dependent upon input and output forms

2.i. Quality Programming with Structured Approach

- Fundamentals of structured analysis and design of programs
- Top-down programming, debugging, testing, implementation
- Analysis of a program's structure for improvement: efficiency, style
- Review of control structures
- Determination of logical equivalence of two differently written programs
- Comparison of efficiency of two differently written programs: execution times, storage requirements, programming time, maintenance time
- Conversion of unstructured design to structured design
- Effect of program languages in structured programming

2.j. Programming Projects Concepts

- Evaluation of programs for good structure
- Team approach: design and code walkthrough
- Program project coordinator (librarian): function and responsibility
- Standards: use of, examples, advantages
- Overview of project management methods: personnel assignment activity sheets, Gantt charts, PERT charts

2.k. The Programming Profession

- Career paths
- Professional ethics
- Licensing and certification considerations
- Professional societies
- Need for continuing education

2.1. Data Representation, Structure, Storage, and Processing

- Characters, fields, records, files
- Data representation, coding, and conversion
- Input-process-output cycle
- Summarizing, selecting, classifying, sequencing methods
- Sorting, searching, merging methods
- Records and block lengths: fixed and variable, blocked and unblocked
- Tables, arrays, stacks, queues, lists, trees
- Direct and inverted files; multirecord files
- Sequential, indexed-sequential, virtual, and direct access files
- Multivolume files and multifile volumes
- File activity, volatility, volume
- File updating
- File maintenance and security
- Reorganizing of files: conversion, modification, restructuring
- Calculation concerns: truncation, rounding, accuracy, modes, precision

2.m. Programming Languages and Logic

- Problem analysis
- Program logic plans: flowcharts, decision tables, structure and hierarchy charts, Nassi-Shneiderman charts, algorithm statements, data-flow diagrams, pseudocode
- Data input and output: types and format
- Use of structured programming constructs and extensions: linear sequence, IF-THEN-ELSE, DO-WHILE, DO-UNTIL, and CASE
- Routines: housekeeping, initialization, end-of-file, end-of-job
- Multiple-level control breaks
- Use of parameter data, sentinel fields, program indicators
- Use of validation and control features: check digits, hash totals, cross totals, batch totals
- Use of compound logical functions based on AND, OR, NOT
- Test data creation
- Debugging methods; traces, snapshots, dumps
- Program correctness: logical equivalence, accuracy
- Program efficiency, timing, and style
- Program documentation: Internal and external
- Basic and advanced syntax and semantics of, and in-depth practical projects in, a problem-oriented procedural language: data format, delimiters, statements, precedence rules, sequence of control, subroutines and linkage
- Basic syntax and semantics of an assembler level language: instruction format, operand structure, register, and storage structure, storage allocation, mnemonic operations codes, labels, symbolic addresses, declaratives, macro instructions, subroutine linkages, address and operation modification, interrupts
- Basic syntax and semantics of one additional specialized language
- Use of language reference manuals
- Anticipation of differences due to implementation

2.n. Interface with Hardware and Software

- Basic computer architecture
- Overview of operating systems
- Job stream control language and usage
- Use of utility programs, text editors, macros, functions
- Use programming products which facilitate programming
- Program modules: storage and usage
- Input - output routines: buffering, paging, overlap, timing
- Compilation - linkage - execution considerations
- Resources accountability
- Use of assembler routines by non-assembler languages and compatibility of data formats
- Operational implications of program style upon operator
- Operational implications of program style upon user

3. Technicans -- Data Management Specialist: Knowledge Requirements

3.a. Data Structure/Business Characteristics of Data

- Simple/special/logical (data model)/physical (conceptual schema)
- Logical structures
- Modelling the organization

3.b. Implementing a Strategic Data Model

- Data Dictionary
- Data modelling approaches
- Structure documentation methodologies
- Automated data modeling/documentation tools

3.c. Database Software and Data Management

- Complexity of data analysis
- Processing and database patterns
- Component usage combinations: standard, back-end database, database machine
- Centralized vs. distributed approaches
- Homogeneous vs. heterogeneous approaches: hardware, operating systems, networks, database management system software
- Language/interface approaches: query languages/4GLs, embedding commands in procedural languages

4. Technicians -- Telecom Specialist: Knowledge Requirements

4.a. Concepts and Terminology

- Transmission codes
- Error detection
- Synchronous/asynchronous
- Full and half duplex
- Networks
- Analog and digital transmission
- Glossary

4.b. Data Communications Standards

- Domestic organizations
- International organizations
- Areas of influence
- Architecture

4.c. Network Architecture

- Historical development
- Components and functions
- Node types
- Network control
- IBM's SNA; DEC's DECNet, others

4.d. Protocols

- TTY compatible
- XModem
- BISYNC 2780/3780
- BISYNC 3270
- Protocol standards (SDLC, HDLC, X.25)

4.e. Modems

- Concepts
- Modem types
- Modem data interface (RS232, 422)

4.f. Multiplexors and Concentrators

- Time division multiplexing
- Split stream modems
- Statistical multiplexors
- Concentrators

4.g. Packet Networks

- Development
- Switching techniques
- Applications considerations
- Network suppliers

4.h. Integrating Voice and Data

- Carriers: AT&T, RBOCs, special carriers
- Bit rate capabilities
- Error rate
- Turnaround delay
- Charges
- WATS

4.i. Private Line Services

- Analog transmission services
- Rate mileage formula
- Analog voice grade channels
- Dataphone digital service & T1

4.j. Satellite Communications

- Background
- Transmission path
- Domestic suppliers
- Satellite Business Systems

4.k. Local-Area Networks

- Concepts and definitions
- Standards
- Available products
- Installation and network administration

4.l. PC Communications Connections

- PC terminal emulation
- Required mainframe support (equipment & software)
- PC to PC
- Protocols
- Current products
- Testing and trouble-shooting products

4.m. Future Trends/Direction

- ISDN
- Value-added networks

C

Developers/Maintainers of Hardware and Software Systems

These people fall in two basic categories -- hardware designers and software designers. The hardware designers further break down into processor designers (electrical engineering skill emphasis) and peripheral designers (mechanical and chemistry emphasis). Software designers include those who work on operating systems and related utilities, and application development tools.

As opposed to applications developers, and especially end users, hardware and software systems developers must have core skills rooted in fundamental math and physics. Basic knowledge requirements are largely the same for both hardware and software developers. However, eventually they become highly specialized to the point where their skills can only be developed through work experience rather than formal education.

There is significant overlap between the knowledge requirements of software designers and hardware processor designers. Both must have an understanding of the environment they are designing for -- i.e., the world of the applications developer. Therefore, most of the knowledge requirements of applications development are also applicable to software and hardware developers whose work is related to the same area (e.g., communications, database). In addition, between the world of applications, software and hardware development, most of the intellectual processes are similar; in all three cases, for example, it is necessary to specify:

- expected inputs (character strings, files/databases, control signal voltages, etc.)
- processing algorithms
- error/exception handling procedures
- desired outputs

The forms of documentation may differ, but such things as structured/heirarchical approaches to problem definition and solution are equally applicable in all areas.

The primary areas of difference between applications developers and software/hardware developers lie in the emphasis placed on company- and industry-oriented knowledge. For example, 2.c (Computers in Organizations) under programmer's knowledge requirements deals with issues such as data center organization and staffing which are of little concern to a hardware designer. Similarly, a bank programmer must know more in general about the banking and finance industry than the hardware designer. However, even here, the hardware designer dealing with ATMs, teller terminals and platform administrative systems must know the environment and requirements of these devices to do an effective job of design.

The table below outlines areas of general knowledge required by software and hardware developers.

Information Structures

1. Data Structures
2. Programming Languages
3. Models of Computation

Information Processing Systems

1. Computer Design and Organization
2. Translators and Interpreters
3. Computers and Operating Systems
4. Special-Purpose Systems

Methodologies

1. Numerical Mathematics
2. Data Processing and File Management
3. Symbol Manipulation
4. Text Processing
5. Computer Graphics
6. Simulation
7. Information Retrieval
8. Artifical Intelligence
9. Process Control
10. Instructional Systems

Mathematical Sciences (systems software emphasis)

1. Elementary Analysis
2. Linear Algebra
3. Differential Equations
4. Algebraic Structures
5. Theoretical Numerical Analysis
6. Methods of Applied Mathematics
7. Optimization Theory
8. Combinational Mathematics
9. Mathematical Logic
10. Number Theory
11. Probability and Statistics
12. Operations Analysis

Physical and Engineering Sciences (hardware emphasis)

1. General Physics
2. Basic Electronics
3. Circuit Analysis and Design
4. Thermodynamics and Statistical Mechanics
5. Field Theory
6. Digital and Pulse Circuits
7. Coding and Information Theory
8. Communication and Control Theory

VI

Conclusions and Recommendations

VI Conclusions and Recommendations

The survey of professional licensing and certification organizations provided a good overview of the current practices in this area, as well as a number of specific issues which JITEC should consider. The review of technology futures and associated knowledge requirements provided the basis for an outline of future examinations which JITEC might consider offering.

Based on these two efforts, INPUT has produced a set of general observations and conclusions regarding the JITEC programs, and a specific set of recommendations for a proposed revised certificate structure. The specific recommendations provide one example of how the general recommendations might be implemented.

A

General Observations and Conclusions

1. Basic Parameters of a Certification Program

In general, both licensing and certification involve most or all of the following:

- an educational requirement to acquire and maintain a body of knowledge
- some level of work experience
- an examination to test whether the candidate has an acceptable understanding of the subject matter
- some sense of responsibility to society with regard to the use of this knowledge
- a code of ethics
- association with a professional society

These factors should all be worked into JITEC's examination program in some manner or another. More details on some of these items are presented below.

2. Changes to JITEC's Certification Programs

Since the number of applicants has grown so large in recent years, JITEC should look into increasing the fees charged to candidates. In addition, a fee for annual listing or for eventual recertification may be considered. It would be possible for the JITEC program to generate revenues of $50-100 million/ annually. These revenues could be used to expand the program, moving into areas that are similar to those currently being pursued by ETS in the United States.

The analysis of future trends in IT (Chapter IV), and the associated knowledge requirements (Chapter V) should be considered as an initial step toward developing a series of manuals that could be distributed to candidates. The subjects discussed would represent the expected knowledge base for each JITEC Certification examination.

The general qualifications for each certificatate should be expanded. Currently there is an age requirement and in some cases an experience requirement as well. There should probably be an education requirement in addition to the other two. Professional references could also be added, perhaps as an extension of the experience requirement to ensure that the cited experience was relevant and that the candidate performed in an acceptable manner.

As additional categories of certification become apparent JITEC could look into working with universities in setting up an educational credentialing program as part of a broader certification program. That is, for some of the more advanced certificates, a combination of education, experience and perhaps a college certificate may be added to enhance the importance of advanced certificates.

Periodic recertification or certificate renewal should also be considered. This could be accomplished in a variety of ways, such as:

- periodic retesting with the current primary test for the certificate
- development of a special recertification test which summarizes the basic test and also contains items relating to changes in IT since the original test was taken
- a process of tracking and giving credit for continuing education (e.g., by developing a Japanese equivalent of CEUs) similar to the U.S. approach
- giving credit for academic activities such as teaching, research and publishing
- evaluation of work experience to determine that the person is currently active in the field

3. Relationships with Other Certification Organizations

During its surveys, INPUT identified a number of organizations that are currently on the leading edge of test development and professional certification. Those which INPUT recommends be visited by JITEC are:

- Institute for Certification of Computer Professionals (ICCP)
- Educational Testing Service (ETC)
- National Board of Examiners in Optometry (NBEO)
- National Association of Securities Dealers (NASD)
- National Institute for Certification in Engineering Technology (NICET)

In addition to a simple visit, INPUT strongly recommends that JITEC attempt to forge a continuing relationship with these organizations. JITEC should also plan a program which will bring it into a closer working relationship with other world organizations that pursue similar projects and interests. As an initial step JITEC should consider attending some of the technology sponsored conferences on education, testing and certification programs being planned for 1989.

One of the leading forces in the development of Information Technology in the United States is the Association for Computing Machinery (ACM). As one of the major associations sponsoring the ICCP, ACM is strongly involved with definitions of curricula, school accreditation, etc. Over the years, ACM has had an ongoing series of projects aimed at defining the knowledge base of IT. It is therefore strongly recommended that JITEC forge a permanent working relationship with ACM as well.

4. General Changes to the ITEE

The ITEE examinations need to become more focussed. That is, specialized knowledge sections that are truly extraneous to the core knowledge being tested have to be eliminated. For example, it is not clear that programmers working in business data processing need to be tested on differential and integral calculus, or that scientific programmers need to be proficient in accounting principles or merchandise circulation. If specialized modules are to be incorporated, JITEC might examine the possibility of structuring examinations so that each candidate can select a set of modules from a large menu of alternatives. The menu could contain choices from both scientific and commercial applications, as well as from basic mathematics, advanced mathematics, computer languages and other subspecialties.

Many of the organizations contacted rely strictly on objective tests. These might include multiple choice, true/false, or fill in the blank questions. Some of the groups interviewed also included essay type questions. There is no evidence one way or the other as to which technique produces better results, although it is clearly more difficult to perform statistical analysis on subjective, essay type questions. However, a number of groups feel that personal communications skills represent a very significant part of a professional's work activity and should be part of a credentialing process. It should also be noted that written essays to test clarity of thinking and communications skills are a very important part of many college and university entrance applications in the U.S. Despite the extra effort involved, these alternatives should to be more fully explored as they relate to ITEE.

JITEC should explore the use of an on-line, real-time computer-based system for administering examinations. Such a system is currently used by the NASD with a great deal of success.

B

Specific Revisions to the ITEE

INPUT recommends that JITEC consider revising ITEE along the following lines:

1. General Certificate Requirements

Each certificate should be subject to 7 general categories of requirements, as follows:

1.a. Relevant Work Experience

Work experience should be required in an area of IT which is relevant to the certificate being sought. Work which is not related should not be considered, or should be considered only at the rate of 1/3 year credit for 1 year of non-relevant experience. Suggested levels of relevant experience are:

- Level I: 3 years
- Level II: 5 years
- Level III: 9 years

1.b. Basic Education Level

A bachelor's degree, or equivalent experience, should be required for the lowest level certificates. Additional graduate work equivalent to a Master's degree (or equivalent work experience) should be required for higher level certificates. When measuring degree-equivalent experience, the time should be in addition to the time required under work experience.

1.c. Completion of Lower Level Certificates

Where relevant, a higher level certificate requires the possesion of the lower level certificate for a minimum period of time before the new, higher level certificate can be granted. Suggested time periods are:

- Level II: 1 year after Level I
- Level III: 3 years after Level II

1.d. Reference Checks

Satisfactory reference checks should be obtained as part of each level of certification. The reference checks should focus on the candidate's ethics as well as his or her professional competence. At least 3 references should be required; at least 1 from a peer, and 1 from a superior.

1.e Passing of Examination

Obviously, passing the certification examination is a key requirement.

1.f. Periodic Recertification

Provision should be made for periodic recertification, or renewal of each certificate. No one should be "decertified" as a result of not having taken the steps to renew their certificate. Rather, each certification should be considered "current" for a fixed time period after award (e.g., 3 years), after which the certificate is considered "non-current" unless renewed. Renewal should be available through a variety of avenues, as outlined in A.2 above.

1.g. Association Membership

As a condition of becoming certified, each candidate should be required to join a professional organization and agree to adhere to its code of ethics.

2. Categories of Certificates

There should be 3 categories of certificates:

2.a. IT Core (ITC) certificates

ITC certificates are oriented towards the core disciplines of IT, and the general knowledge requirements of this core. The four general categories of people who would get an ITC certificate are:

- hardware developers
- system software developers
- telecommunications system developers
- applications developers

2.b. Applications Development Specialist (ADS) certificates

ADS certificates are an extension of the certificates for Applications developers. In order to obtain an ADS certificate, the candidate must first hold the same level of ITC certificate. ADS certificate areas could include:

- system auditors
- database management specialists

2.c. Industry Specialist (IndS) certificates

IndS certificates are also an extension of the certificates for Applications developers. Whereas the ADS certificates demonstrate special expertise in a functional area related to development or management of applications, the IndS certificate attests to the person's broad knowledge of the applications in a specific industry or field, such as banking/finance, manufacturing, process control, etc. In order to obtain an IndS certificate, the candidate must first hold the basic level ITC certificate.

3. Levels/Types of Certificates

Within the above categories, there should be multiple levels of certification, as well as some degree of specialization. The complete list of proposed certificates is as follows:

Level I

Level I is the basic, or core level of certification. At this level, the emphasis is on knowledge of basic facts, tools and concepts across the range of IT. Examinations at this level will normally be objective (true/false or multiple choice), and there will be a large number of persons seeking certification.

- ITC: Information Technologist

  This is the basic level certificate in IT. It covers all of the general core knowledge requirements identified in Section V.C for applications and systems developers. One basic certificate, without any specialization, reflects the basic concept that there is a core which all IT professionals must know.

- ADS: Systems Auditor
  Database Specialist
  Telecommunications Specialist

  These certificates represent basic levels of expertise in specialized areas related to applications development. The requirement of a basic ITC certificate as prerequisite for these certificates is to ensure that these specialists have a solid grounding in the core disciplines and understand how their specialized role fits into the overall picture.

- IndS: (as many as appropriate, including such areas as banking/finance, manufacturing, etc.)

  Since these certificates are also intended for IT professionals, they have the same logic of prerequisites as ADS. The need for such certificates, and the definitions of the business areas to certify, are left to JITEC to determine. It is presumed that only one level of certification in appropriate in the IndS area.

Level II

Level II certificates indicate an intermediate level of professionalism, while recognizing that the individual's career must become focussed in one specific area. Rather than emphasizing the core IT knowledge base, these certificates focus on specific requirements in their base area. In addition, the focus shifts from knowledge about tools and techniques to the practical application of these tools to specific problems.

- ITC: Hardware Engineer
  Software Engineer
  Telecommunications Engineer
  Applications Development Engineer
  These 4 certificates are all based on the specific knowledge requirements for the respective areas, as identified in Sections V.C and V.D.

- ADS: Senior Systems Auditor
  Senior Database Specialist
  As with the basic level of ADS, these certificates represent advanced levels of expertise in specialized areas related to applications development. Since they are applications oriented, the intermediate level Applications Development Engineer ITC certificate is a prerequisite.

Level III

The single Level III certificate indicates that the highest level of IT professionalism requires the individual to integrate all the core areas in an effective manner. This level of certification is also focussed on the requirements of managing IT as a strategic resource.

- ITC Information Scientist
  In order to ensure the breadth of experience appropriate to this level of certification, prerequisites include significant managerial experience and the posession of at least 3 out of the 4 Level II ITC certificates.